

Discovery of an Internasal Bone in *Hynobius maoershanensis* (Urodela: Hynobiidae)

Jianli XIONG¹, Xiuying LIU² and Xiaomao ZENG^{3*}

¹ Animal Science and Technology College, Henan University of Science and Technology, Luoyang 471003, Henan, China

² School of Agriculture, Henan University of Science and Technology, Luoyang 471003, Henan, China

³ Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu 610041, Sichuan, China

Abstract Internasal bones have generally been recorded in teleostean and tetrapod fossils, being absent in most extant vertebrates. Presently, there has been one case of the internasal bone discovered in a living salamander, *Pseudohynobius puxiongensis* (Caudata: Hynobiidae). The second case discovered in living salamanders is reported in this article, which is present in one of five specimens of *Hynobius maoershanensis*, a species endemic to China. This case is again regarded as individual variation. Thus, the presence of an “internasal bone” may represent intraspecific variation and is thus a misleading taxonomic character.

Keywords salamander, internasal bone, skull, anatomy, individual variation

1. Introduction

The internasal bone, an intramembranous bone usually between the nasal bones on skull, was broadly recorded in the teleostean and tetrapod fossils (Watson, 1929; Goodrich, 1958; Carroll, 1964; Romer and Parsons, 1977; Beaumont, 1977; Duellman and Trueb, 1994; Panchen, 1980; Heatwole and Carroll, 2000; Schoch and Rubidge, 2005), and absent in most extant vertebrates, though present in the fishes *Latimeria chalumnae* and *Neoceratodus forsteri* (Romer and Persons, 1977; Zhang, 1986), the salamander *Pseudohynobius puxiongensis* (Fei and Ye, 2000), and the rats of the genus *Proechimys* (Martin, 1970). Thus, when the bone was detected in living animals, one might pay particular attention to, and sometimes regarded it as an important diagnostic feature (e. g., *P. puxiongensis*, Fei and Ye, 2000), which is likely to cause incorrect classification (Peng *et al.*, 2010).

As a second case in living salamanders except *Pseudohynobius*, we recently identified the internasal

bone in one of five specimens of the species *Hynobius maoershanensis*. This species was named by Zhou *et al.* (2006) based on the specimens collected in the Maoershan National Nature Reserve, Xing'an County, Guangxi, China. Regarding its rare occurrence in living tetrapods, we give a brief report as follows, and try to estimate its value on taxonomic diagnosis.

2. Materials and Methods

Five adult specimens of *H. maoershanensis* (CIB-XM2101, CIB-XM2121, CIB-XM2127, HNUSTM1005134 and HNUSTM1005137) were collected by Mian HOU and Qin CHEN from swamps in the Maoershan National Nature Reserve on 25 January 2006 (25°53' N, 110°25' E; altitude 1986 m). The sampling site of the specimens is the same as the type locality described by Zhou *et al.* (2006). The measurements of head length and total length of the five specimens were listed in Table 1. The skulls were prepared using double-staining technique (Tan, 1993), and the prepared skulls were examined with a LEICA MZ6.0 dissecting microscope. The vouchers are now deposited at the Chengdu Institute of Biology, Chinese Academy of Sciences (CIB) and Henan University of Science and Technology Museum (HSTUM).

* Corresponding author: Prof. Xiaomao ZENG, from Chengdu Institute of Biology, Chinese Academy of Sciences, with her research focusing on cytology and molecular evolution of amphibians and reptiles.

E-mail: zengxm@cib.ac.cn

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3. Results

Five skulls of *H. maoershanensis* closely resemble one another in the structure of the dorsal skull (Figures 1, 2). All have the same basic skeletal elements, including paired premaxillae (pm), maxillae (m), nasals (n), frontals (f), lacrimals (l), prefrontals (pf), pterygoids (pt), prootics (po), squamosals (s), quadrates (q), parietals (p), exoccipitals (ex) and operculums (o).

A single, oval-shaped internasal bone is situated medially and surrounded by the nasals in a medium-sized specimen CIB-XM2127 (Figure 1, Table 1). Both the shape and arrangement of this bone are the same as those reported in *P. puxiongensis* by Fei and Ye (2000). The internasal bone is absent in all other specimens examined (CIB-XM2101, CIB-XM2121, HNUSTM1005134 and HNUSTM1005137), and the place is presented by a strip suture surrounded by premaxillae and nasals (e. g., CIB-XM2121, Figure 2).

Table 1 The measurements of the five specimens of *H. maoershanensis* (mm)

Specimens	Head length	Total length
CIB-XM2127	14.4	134.8
CIB-XM2101	14.1	130.3
CIB-XM2121	13.3	129.6
HNUSTM1005134	16.1	161.5
HNUSTM1005137	14.9	135.4

4. Discussion

As a diagnostic feature, the presence of internasal bone was documented in the skulls of some fossil teleostean and tetrapods. An oval internasal bone is situated medially in the frontonasal suture of *Osteolepis* (Goodrich, 1958). Four internasal bones were separated by rostral bone and post-rostral bone, and two bones arranged anterior and posterior on each side of the skull in *Eusthenopteron* (Romer and Parsons, 1977). A rhomboid internasal bone, surrounded by premaxillae and nasals, is present in *Ichthyostega* (Duellman and Trueb, 1994). A pair of internasal bones are present in *Acanthostega gunnari* (Clack, 1994). A pair of semicircular internasal bones are surrounded by premaxillae and nasals, and are separated medially in *Loxomma* (Panchen, 1980) and *Megalocephalus* (Heatwole and Carroll, 2000). A triangular internasal bone is present in *Tersomius texensis* (Carroll, 1964; Huttenlocker *et al.*, 2007) and *Micropholis stowi* (Schoch and Rubidge, 2005; Huttenlocker *et al.*, 2007), with the same position as in *Ichthyostega*. A single

or paired internasal bone is present in Baphetids as in other loxommatid species (Watson, 1929; Beaumont, 1977). An unpaired internasal bone is present in *Deltaherpeton hiemssstrae* (Bolt and Lombard, 2010). As the number, shape and arrangement of the internasal bone vary in different fossil taxa, the character is often used in taxonomic identification of fossil vertebrates (Watson, 1929; Beaumont, 1977; Bolt and Lombard, 2010).

The internasal bone is rarely detected in extant taxa as compared with fossils. When present, it is considered to have taxonomic significance but sometimes otherwise. An internasal bone is located in the anterior and dorsal part of the skull in *Neoceratodus forsteri* (Zhang, 1986). In *Latimeria chalumnae*, a rare “living fossil”, internasal bones are also present, of which the number, shape and position are the same as those in *Eusthenopteron* (Zhang, 1986). In a hylid frog, *Smilisca fodiens*, an internasal bone presents anterior and dorsal to the premaxillae (Trueb, 1970; Smith *et al.*, 2007). However, the internasal bone has also been regarded as an unreliable character for other species. The bone was sometimes found in a few specimens among a larger sample, e. g., Martin (1970) reported a small narrow internasal bone found in the frontonasal suture in two populations of the spiny rats, *Proechimys guyannensis*. Dalquest and Scheffer (1944) discovered the bone only in an individual pocket gopher (*Thomomys talpoides*). An oval internasal bone was observed in one specimen of *P. puxiongensis* (Fei and Ye, 2000). Peng *et al.* (2010) rediscovered individuals of *P. puxiongensis* at its type locality, after osteological analyses, all the characters observed in the rediscovered specimens were identical to the original description of the holotype may have been due to intraspecific variation. Herein, we show the presence of this element in one of the collected specimens. Thus, we consider the internasal bone of *H. maoershanensis* as a variable osteological character, which is the second case of individual variation in living salamanders after *P. puxiongensis*.

Skeletal characteristics are unanimously supposed to be much more reliable identification than others, and are often used in a diagnosis. However, skeletal variations, sometimes even in the skull, exist among a group of individuals (Hanken, 1984; Shubin *et al.*, 1995; Martínez and Cola, 2011). So, we suggest more samples need to be checked and more attention to be paid on skeletal variation when using them in a taxonomic diagnosis.

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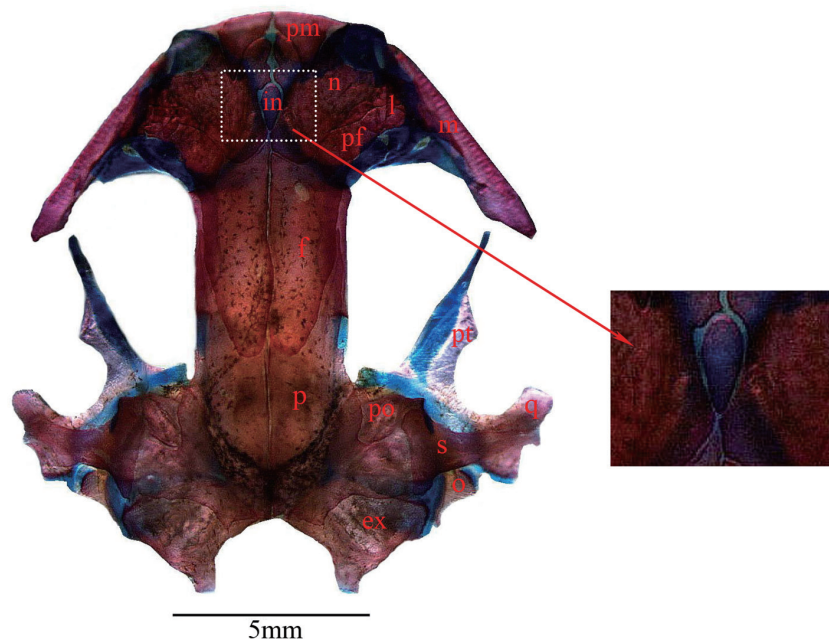


Figure 1 The skull of *H. maoershanensis* with an internasal bone (CIB-XM2127). See the abbreviations in the text.

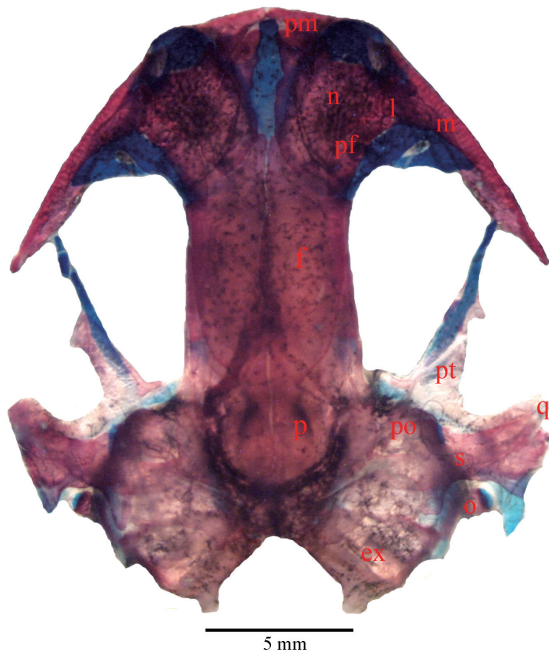


Figure 2 The skull of *H. maoershanensis* without internasal bone (CIB-XM2121). See the abbreviations in the text.

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